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14. ABSTRACT

This project provided funds for initial investigations about the behavior of a large hole in the surfzone. A backhoe was used to create a 10-m diameter, 2-m deep hole that simulated the change to the morphology caused by an explosion near the shoreline. The hole was created near the water line at low tide, and instrumented with many acoustic Doppler current meters. As the tide rose, continuous surveys of the bathymetry within and near the hole were performed, allowing detailed investigation of the evolution of the bathymetry as waves reached and overtopped the hole. Waves and currents were measured from offshore of the hole (about 2-m water depth) to near the landward extent of the run up above the hole. As water reached the altered beach topography, sediment was transported such that the hole began to fill (a combination of collapse of the sides of the hole and sediment transport towards the hole). The hole was filled, and the beach face returned to its initial configuration within one tidal cycle. The experiment was performed 3 times, first to gain experience creating a hole, second to learn how to instrument the hole rapidly, and the third to monitor in detail the waves and currents within the hole.

Graduate student Jim Thomson analyzed the current meter data and surveys to show that the water in the hole formed a seich with frequency of oscillation that changed as the hole evolved from circular to semi-circular. The observed frequencies were similar to those predicted for a circular basin and for a semi-circular resonator.

Dye patterns showed the path of water (and thus of sediment or other tracers in the water) as the hole evolved and slowly filled in.

15. SUBJECT TERMS

nearshore bathymetry, sediment transport, surf zone waves and currents

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EVOLUTION OF A SURFZONE HOLE: PART I, PILOT

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OVERALL OBJECTIVES

The long-term goals were to determine the temporal evolution of a large man-made hole in the surfzone seafloor, and to observe the effect of the hole on waves, currents, and sediment transport. The approach was to create a hole near the shoreline, and instrument it before the tide rose, followed by intense bathymetric surveys of the hole as it evolved.

TASKS COMPLETED:

Several holes were created with heavy equipment near the shoreline on the beach at the US Army Corps of Engineering Field Research Facility, Duck, NC. (Figure 1).

Figure 1. Backhoe digging a hole in the sand near the low-tide water line.

Each hole was approximately 10 m diameter and about 2 m deep, and was dug during the falling tide near the low-tide water line. Acoustic Doppler current meters were deployed offshore of the hole in 1- to 3-m water depth, and after the hole was created additional acoustic Doppler current meters were deployed near and within the hole (Figure 2). Dye was deployed within and upstream of the hole to visualize flow patterns.

Figure 2. Completed hole at low tide. The white cylinders hold current meters, deployed within and near the hole.

Bathymetric surveys were performed before the hole was created, and then nearly continuously as the hole evolved under the influence of waves and currents. After a few practice runs, we were able to create holes according to specifications (Figure 3).

Figure 3. Completed 10-m diameter, 2-m deep hole at low tide. Current meters were deployed within and around the hole, and measured waves and flows as the tide rises and water covers the depression.

The wave and current data have undergone quality control, as have the bathymetric surveys. The data are available to the public.

RESULTS:

The primary result of this pilot project was the determination that holes can be created to design specifications, and can be instrumented rapidly so that observations can begin before the tide rises.
In addition, visual observations and surveys show that on a coarse sand beach a hole fills in within one tidal cycle, leaving the beach in its original configuration (Figures 4 and 5).

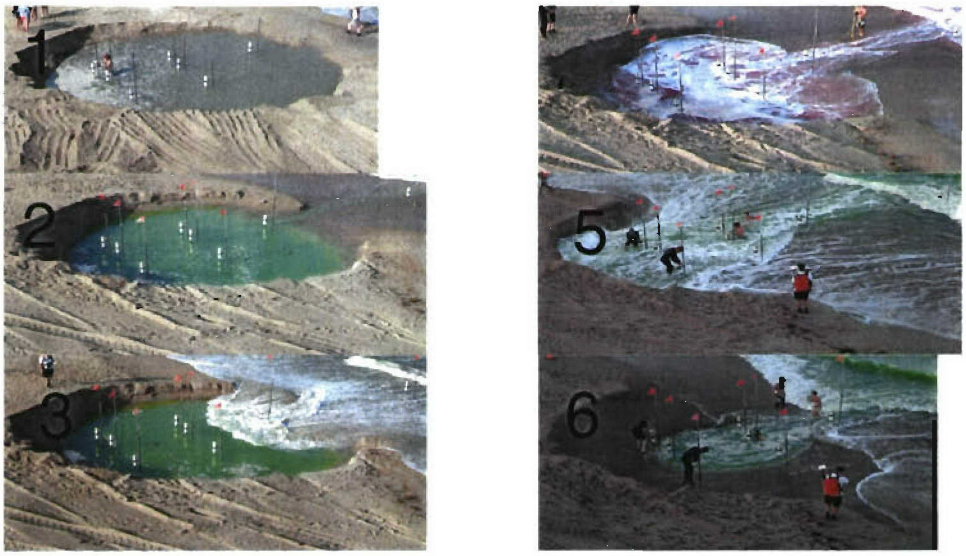

Figure 4. Photographs of a hole as it evolves from its initial configuration (upper left). Time increases from upper left to lower left, then from upper right to lower right. Dye shows the flow patterns as waves run up into the hole, and strong flows leave the center of the depression.

Figure 5. Photographs of the hole (left) 3 hours after waves started to reach it, and (right) the next day after a tidal cycle (almost all traces of the hole have vanished).

The bathymetry was monitored with GPS survey equipment (walkers and waders with backpacks) and with hand measurements every 10 minutes. Most of the hole had filled in within 4 hours of low tide, with areas near the center of hole filling in last because there was a strong outflow down the centerline, whereas wave-induced sediment transport resulted in collapse of the steep sidewalls, resulting in filling of the sides of the hole.

IMPACT:

One impact of this project is the determination that holes and other perturbations to nearshore bathymetry can be made with heavy equipment in a manner that allows instrumentation before the bathymetry begins to evolve. A second impact is the determination that for the beach investigated here (coarse grains), a large man-made hole fills rapidly, and within one tidal cycle there is little, if any of the perutrbation remaining.

PUBLICATIONS:

There have not yet been any publications resulting from this pilot project.

STUDENT INVOLVMENT:

WHOI-MIT joint program doctoral students Alex Apotsos and Jim Thomson participated in this project, along wth an undergraduate intern. The students gained valuable experience learning to make observations in the field, performing initial data quality control and analysis, and working with Drs. Raubenheimer and Elgar to interpret the results.